

Expert system on the mobile platform for diagnosis of faults in the work of IT-equipment

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Abstract. The problem of increasing the efficiency of maintenance and repair is being solved by applying flexible strategies using expert systems implemented in mobile applications. An expert system is a set of programs that accumulates knowledge of specialists in a particular domain and replicates this empirical experience for consultations of less skilled professionals. Mobile application is a modern software which intended for working on tablets, smartphones and other mobile devices. This article deals with a detailed description of the work of the expert system, the rules and facts of work are formed. The output of solutions diagnosing expert system is beeing developed. The implementation of the automatic synchronization of the mobile application with the technical documentation of troubleshooting is scheduled. The improvement of the mechanism for predicting the malfunction and solution as an expert system dialogue with the user is occurred. The organization of work in offline mode in the absence of a network connection has been planned.

1. Introduction

Research and analysis of existing strategies show that the planned maintenance and repair strategy, that is, schedule strategy leads to a significant overspending of labor and material resources [1]. Moreover, this strategy does not reduce the likelihood of post-repair failures. The solution of this problem is the use of more flexible strategies for maintenance and repair (MRO), which will combine to ensure the reliability of computing technology through long-term diagnostics and prediction — projective and predictive [2]. The application of such MRO strategies requires support by information systems, including mobile ones. The purpose of such systems is to provide service engineers with access to the equipment manufacturer’s documentation, credentials on its actual state, typical problem databases and methods for its resolving. The use of such MRO strategies ensures troubleshooting until the system encounters obvious problems.

A preventive maintenance strategy is effectively and fully can be implemented in that case if staff has the knowledge, skills and time needed to carry out the relevant activities.

Currently, there is a wide range of specialized software products and expert systems for using in this subject area, among which there are software systems such as the Fusion Server Tools, the Fusion Server Tools Info Collect. These expert systems are system software (software), which increases the time of the engineer and reduces the amount of volume of works on troubleshooting due to the lack of its mobility.

After reviewing the equipment troubleshooting documentation using the example of HUAWEI [3], using only desktop software, the following conclusions were made about the need to develop a mobile

application, since the expert systems on the desktop platform are not mobile. According to statistics for 2017, the failure of mobile devices compared to desktop ones was significantly lower than in 2016 [4]. The failure rates of desktop computers have not changed. Consequently, the development of expert systems on a mobile platform is relevant.

2. Application of expert systems

The expert system (ES) is a complex of programs that accumulates the knowledge of specialists in a specific subject area and copies this empirical experience for consultations of less qualified specialists [5].

ES can be presented in the form of applied information systems or be independent individual shells with universal functions in the role of a human expert or consultant who will propose solutions of the problem situation in a specific subject area.

An important moment is to think over the organization of the interface part, namely, to organize an IP dialogue with the use during the planning of any information system (IS).

This is especially important when planning an ES, because the questions asked by the user must be understandable and must be proceeded at the right when there is a definite situation. Therefore, the dialogue technique should be carefully considered at the design stage of the EC.

A typical EC consists of such main components as: solver (interpreter), working memory (RP), also called database (DB), knowledge base (KB), knowledge acquisition components, explanatory and dialog components [6].

The expert system works in two modes: the acquisition of knowledge and problem solving (also called the consultation mode or the mode of using the ES).

If we consider the mode of acquiring knowledge, then dialogue with the EC is carried out with the help of a knowledge engineer. The problem situation is described by the expert in the form of a set of rules and facts. In any subject area presented to study a problem situation, there are objects that have their own characteristics and values - these are facts. Manipulating facts to resolve a problem situation in the subject area - there are rules. To solve a problem situation, an expert needs to acquire knowledge and fill the system with them. The number of identified facts and rules by an expert directly affects the correctness of the solution of the problem from the problem area.

$$\text{Given a set of facts, } F = \{f_{ij}\} \cup \{q_i\} = (f_1, f_2, \dots, f_n) \quad (1)$$

which consists of elements of two types. The a_{ij} elements define ordinary declarative knowledge from a particular subject area. The q_i elements determine the type of interaction with the external environment. In the designed ES in the dialog box, the user is provided with questions concerning the specific problem situation that has arisen. The user can agree with this fact or not, depending on the choice, the EC will provide the following question: $q_i = f_{i_1}, \dots, f_{i_s}$. (2)

$$\text{Products in this system are } f_{ij} \rightarrow q_m = \{f_{m_1}, \dots, f_{m_k}\} \quad (3)$$

Many facts and products are collected in a certain system, represented as a diagnostic OR column with terminal vertices q_1, q_2, q_3, q_4, q_5 . Figure 1 shows a fragment of such a graph.

In the "OR" column, the orientation of the arcs shows the direction of the output. The natural division of the graph vertices into tiers reflects the depth of the output.

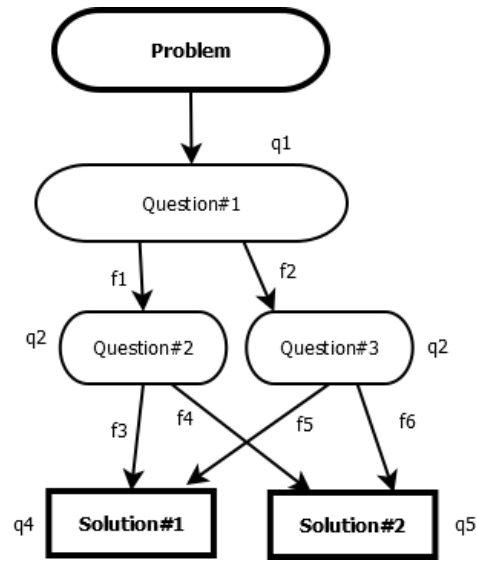


Figure 1. Diagnostic Graph

The principle of operation of the designed ES is as follows. After the user accesses the ES, we get to the top q_1 of the initiating question to the user in the form of the corresponding dialog menu:

$$q_1 = \{f_1, f_2\} \quad (4)$$

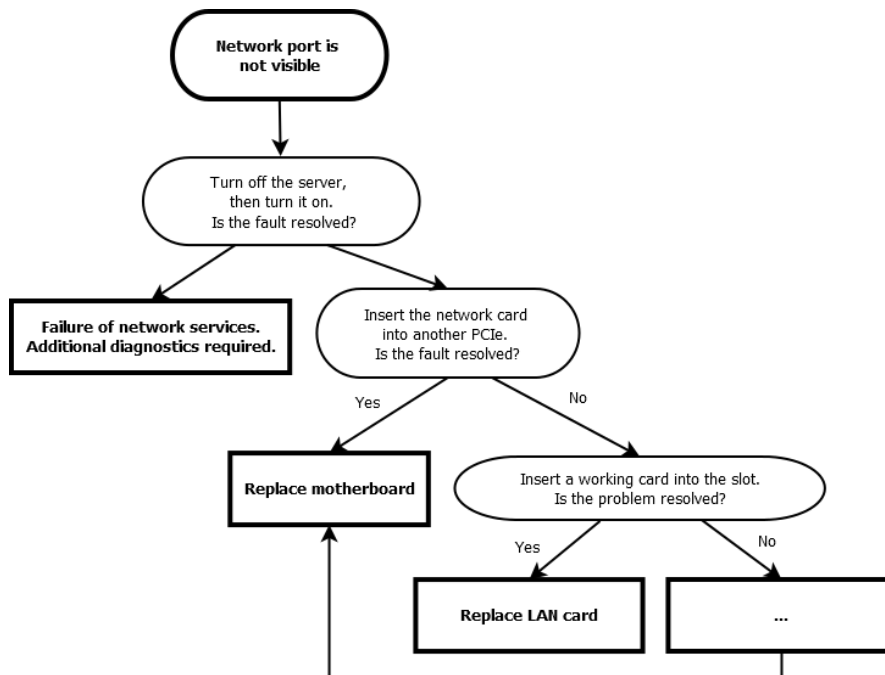


Figure 2. Finding solutions of the diagnosing expert system

Suppose, to the question of the system: “Which of the facts f_1, f_2 takes place?” The user answered: f_1 . As a result, we follow the link f_1 to the working field and get to the new vertex - question q_2 :

$$q_1 = \{f_1, f_2\} \quad (5)$$

where this procedure is repeated.

In the end, we find ourselves in one of the terminal vertices, where the user receives a message about the result (figure 2).

3. Means and methods of development

On the basis of the conducted research, the most frequent were issues related to the Internet and other Internet peripherals, the main reasons for contacting engineers were identified, and diagnostic diagrams were drawn up. The basis of the expert system was the knowledge base, which contains the most frequent questions for contacting the engineers of the provider used.

As the main environment for developing a mobile application, it was decided to use the IDE Android Studio, since this IDE was created specifically for developing applications for Android devices [7].

The application will use the SQLite database (DB), because it is included by default in the Android OS. SQLite supports standard relational database capabilities - syntax, transactions. In addition, SQLite requires a very small amount of memory to work. Using SQLite in the Android OS does not require installation of the database or administration [8]. You specify the SQL query for working with the database and the necessary administrative operations are performed automatically. Figure 3 shows the mobile application data model.

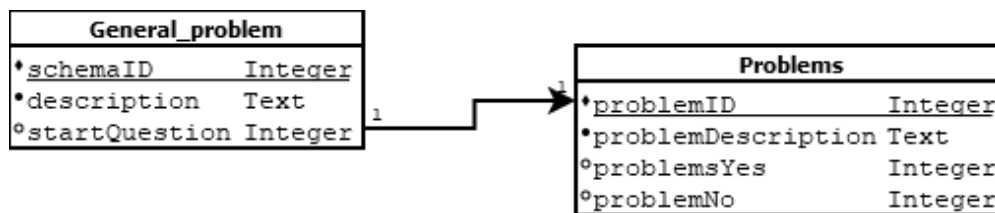


Figure 3. Application data model

The mobile application developed using the Android Studio IDE consists of three active windows:

The main window is built on the basis of a table from a database consisting of key questions about a particular symptom.

A survey window is built by displaying leading questions to the user based on his symptom, where the user interacts with the system by agreeing or disagreeing with the provided question using simple “Yes” and “No” answers, based on which the system draws conclusions and either asks an additional question or inform the user about the possible diagnosis (figure 4).

The window "About the program" - contains informative character about the developer and purpose of the program.

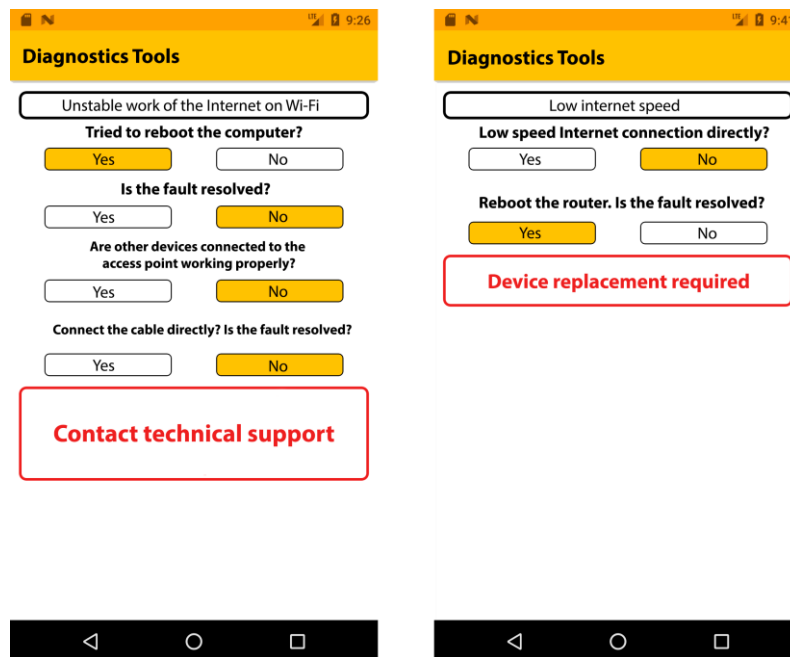


Figure 4. Interrogation window views

In accordance with the diagnostic circuit selected in the main window of the information system, a block with the name of the diagnostic circuit is displayed on the interrogation window and is fixed in the upper part of the interrogation window. Below this block, the user is presented with a leading suggestive question corresponding to this diagnostic scheme with answer choices in the form of “Yes” and “No” buttons. When a user chooses any option, the expert system processes the result and makes a decision in accordance with the diagnostic scheme to provide the user with the next leading question or to withdraw a possible diagnosis. The output unit may be diagnosed visually highlighted in a red frame in order to attract attention to simplify user interaction.

Conclusion

As a result of the work, the expert system was designed in the form of a mobile application for diagnosing malfunctions in the operation of computing equipment.

The system implements the troubleshooting functions of computer technology and allows service engineers to access equipment manufacturer's documentation, credentials on its actual state, databases of typical problems and methods for eliminating them.

Currently, a database is being filled; research work is being carried out with Internet service providers of the city of Krasnoyarsk, providing services. All requests from customers who have experienced any kind of malfunctioning hardware, software or network are processed.

In the future, we plan to implement automatic synchronization of technical documentation with the knowledge base, improve the output mechanism, and organize work in offline mode.

The second direction of development of the worked out solution is the implementation of remote monitoring and auto-polling about the state of equipment for predicting and identifying future malfunctions in computing technology.

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